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## Comment on cp-2020-164

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Community comment on "On the tuning of plateaus in atmospheric and oceanic  $^{14}\text{C}$  records to derive calendar chronologies of deep-sea cores and records of  $^{14}\text{C}$  marine reservoir age changes" by Edouard Bard and Timothy J. Heaton, *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2020-164-CC1>, 2021

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### RESPONSE to the PREPRINT of E. Bard and T.J. HEATON (B&H)

"On the tuning of plateaus in atmospheric and oceanic  $^{14}\text{C}$  records to derive calendar chronologies of deep-sea cores and records of  $^{14}\text{C}$  marine reservoir age changes"

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### Abstract

In response to an extended comment of Bard and Heaton (2021) (B&H) on the synthesis paper of Sarnthein et al. (2020) we counter their reservations both in the field of statistics and about the technique of  $^{14}\text{C}$  plateau-tuning (PT), like in a manual, one-by-one, by means of telling lines of evidence. In particular, we single out the following points of view:

-- We show proof that results of PT of marine sediment records are hardly affected by bioturbational mixing and changes in foraminifera abundance, given the limitation of PT to cores with sedimentation rates  $>10$  cm/kyr;

-- We illustrate the importance of initial guidelines of conventional stratigraphy to confine overall sedimentation rates as boundary condition and to derive alternative modes of PT for a whole suite of  $^{14}\text{C}$  jumps and plateaus in a sediment record,  $^{14}\text{C}$  structures to be compared to those of the paired atmospheric reference record of Lake Suigetsu.

-- Extended tests (Balmer & Sarnthein, 2016) revealed that changes in sedimentation rate *per se* are unable to generate a complete suite of  $^{14}\text{C}$  plateaus by now already defined in some 20 sediment cores and independently corroborated by various lines of local evidence.

-- Over the interval 10 - 15 cal. ka, the plateau structures of the Suigetsu atmospheric (atm)  $^{14}\text{C}$  record are clearly paired with well-defined tree ring- and floating tree ring-based  $^{14}\text{C}$  structures (IntCal13; Adolphi et al., 2017). By comparison, we suggest that prior to 15

cal. ka the continuing  $^{14}\text{C}$  fine structure of noisy Suigetsu with  $^{14}\text{C}$  jumps and plateaus is by far more realistic than the admittedly smoothed  $^{14}\text{C}$  trend of the Hulu speleothem and IntCal20, records that may also suffer from unknown but likely changes in the Hulu Dead Carbon Fraction (DCF).

-- By comparison to Holocene and late deglacial times, where PT may be constrained by tree ring records, glacial-to-early deglacial marine reservoir ages (MRA) can indeed be regarded as largely constant over time spans as long as  $^{14}\text{C}$  plateaus about 500-1000 yr. In turn, major MRA changes are confined to more extended intervals of climate, sea ice cover, and ocean circulation similar to those of Heinrich events, Dansgaard Oeschger cycles, and their multiples.

-- Per analogy to the record of 10-15 cal. ka, overall  $^{14}\text{C}$  changes and shifts in the radiocarbon clock at 15-29 cal. ka are necessarily focused to inter-plateau times, just 18 % of the total time span as estimated by B&H. This concept indeed was first documented by means of PT.

-- We show that minor intra-plateau changes in MRA indeed exist, although they cannot be specified by our limited sampling resolution of  $\sim 50$ -150 yr. Careful inspection of the complete suite of plateaus in each core enabled us occasionally to identify distinct intra-plateau changes.

-- Concerns about low sampling density are unfounded.  $^{14}\text{C}$  structures in pelagic sediment records like boundaries of  $^{14}\text{C}$  plateaus, were not "under-constrained" by  $^{14}\text{C}$  ages but systematically documented by iterative sampling.

-- The box model discussion is scientifically correct. However, it only deals with *Pla*, the planktic  $^{14}\text{C}$  concentration of ocean surface waters, and not with  $\text{MRA} = (\text{Pla} - \text{Atm})$ .

In view of these findings the technique of PT cannot be regarded as 'result of inherent pitfalls'. Rather PT is emerging as great opportunity to generate both a suite of narrow-standing and robust age tie points for marine sediment records and a record of short-term changes in MRA and paleoceanography for last glacial-to-deglacial times in ocean sediment cores where independent high-resolution calendar age information is usually rare.

ALL DETAILS of this response letter to cp-2020-164 are given in the attached file, moreover, in a companion letter submitted by PM Grootes and M. Sarinthein.

Please also note the supplement to this comment:

<https://cp.copernicus.org/preprints/cp-2020-164/cp-2020-164-CC1-supplement.pdf>